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16. ABSTRACT The paper discusses efforts by the U.S. and Canada to develop an accurate and highly detailed 1985 emissions inventory which focuses on three pollutants (SO_2, NOx, and VOCs) believed to play a critical role in the formation of acid deposition, and also includes information on species such as HCl, HF, NH_3, and alkaline particulate matter. The 1985 emissions inventory is also designed to meet a number of research objectives for the U.S. National Acid Precipitation Assessment Program (NAPAP). The U.S. and Canadian data collection methodologies exhibited differences in data formats, classifications of point and area sources, emission factors, source classification codes, units of measurement, key data elements, and quality control checks. U.S. and Canadian modeling inventories differ in their respective grid sizes, allocation factors, and species classes for VOCs and total suspended particulates. The inventory methodologies used by each country were adapted and standardized to ensure consistent processing of data.

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Emission	Stationary Sources	14G
Inventories	Acid Rain	15E
Precipitation (Meteorology)		04B
Acidification		07B, 07C 20M
Assessments		14B
Sulfur Oxides		
Nitrogen Oxides		
Organic Compounds		
Volatility		

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1985 U.S. AND CANADIAN EMISSIONS INVENTORY

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ABSTRACT

In recent years the U.S. Environmental Protection Agency's (EPA's) Office of Research and Development has worked with Environment Canada to conduct research on problems posed by acid deposition in North America. One fundamental objective of the research is to quantify and geographically locate anthropogenic and natural sources of atmospheric emissions that may contribute to acid deposition. The magnitude and location of such emissions are important to atmospheric transport models which relate emissions, atmospheric transformation processes, and deposition. The U.S. and Canada are developing an accurate and highly detailed 1985 emissions inventory which focuses on three pollutants believed to play a critical role in the formation of acid deposition - sulfur dioxide, nitrogen oxides, and volatile organic compounds (VOCs) - and also includes information on species such as hydrogen chloride, hydrogen fluoride, ammonia, and alkaline particulate matter. The 1985 emissions inventory is also designed to meet a number of research objectives for the U.S. National Acid Precipitation Assessment Program (NAPAP).

When two countries historically have developed independent emissions inventories for assessment and modeling purposes, substantial differences in data collection methodologies and data formatting for modeling purposes will exist. The U.S. and Canadian data collection methodologies exhibited differences in data formats, classifications of point and area sources, emission factors, source classification codes, units of measurement, key data elements, and quality control checks. U.S. and Canadian modeling inventories differ in their respective grid sizes, allocation factors, and species classes for VOCs and total suspended particulates. The inventory methodologies used by each country were adapted and standardized in order to ensure consistent processing of data.

In sum, with much cooperative work between involved countries and through the use of standardized methodologies and extensive quality control, complete and accurate international emissions inventories can be developed successfully.

1985 U.S. AND CANADIAN EMISSIONS INVENTORY

1.0 BACKGROUND

The 1985 U.S. anthropogenic emissions inventory is divided into two major categories, point and area sources. Point or stationary sources included in this inventory emitted at least 90.7 megagrams (100 tons) of a criteria pollutant (NO_x, SO_2, TSP, VOC, or CO) during calendar year 1985. Area sources comprise both mobile and point sources that emitted less than 90.7 megagrams of a criteria pollutant during 1985. Data for each industrial process that meets these criteria are supplied to EPA by the state environmental agencies on an annual basis through a computer system called the National Emissions Data System (NEDS). Similarly, provincial agencies supplied Environment Canada with 1985 point source emissions and operating data.

The area source emissions estimates for approximately 100 area source categories are calculated by the Federal agencies using a series of computer programs. This process is primarily a top-down strategy which allocates national emissions estimates to the state and county levels in the U.S., and the provincial and sub-provincial levels in Canada.

The data collection efforts for 1985 point source data were prioritized to ensure that the inventory would include critical parameters for each source. Estimates of sulfur dioxide (SO_2), nitrogen oxides (NO_x), and volatile organic compound (VOC) emissions were given the highest priority. In addition, the effort concentrated on facilities emitting at least 907 megagrams (1000 tons) which produce the majority of point source SO_2, NO_x, and VOC emissions. Of the 50 data elements in a NEDS record (see Figure 1), the U.S. data collection effort focused on the 14 types of data most important for the National Acid Precipitation Assessment Program (NAPAP) community. These priority items include annual emissions estimates for SO_2, NO_x, and VOC; maximum design and annual operating rates; Source and Standard Industrial Classification codes; emissions control equipment and efficiencies; fuel characteristics; stack parameters; location data; and operating schedules.

One ton equals 907.1860 kilograms

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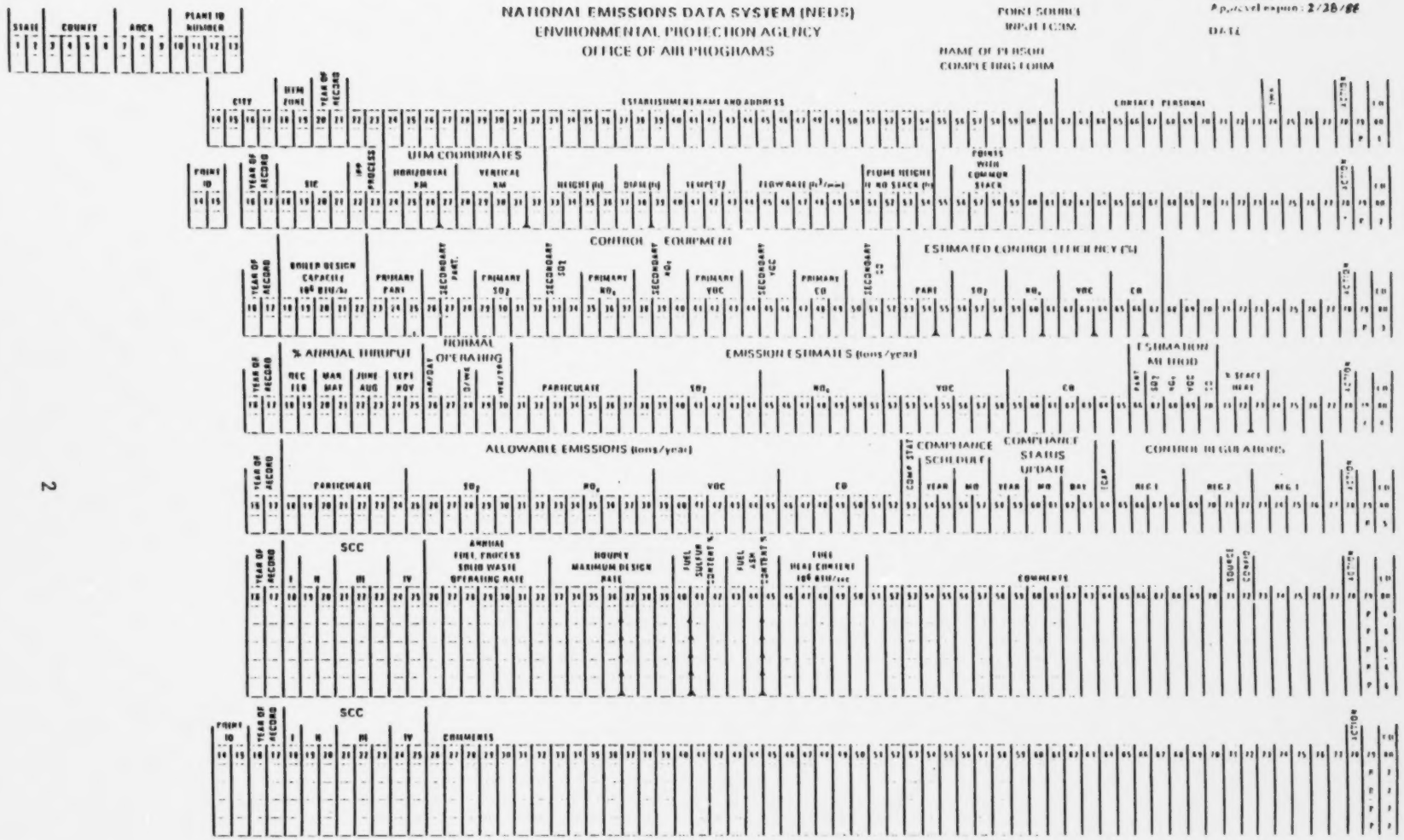


Figure 1. NEDS Record Format

The final 1985 NAPAP emissions inventory will contain estimates of anthropogenic emissions of the three primary pollutants, SO_2, NO_x, and the reactive hydrocarbon portion of VOC; the other two criteria pollutants, carbon monoxide (CO) and total suspended particulates (TSP); and four other chemical species believed to play an important role in acid deposition, primary particulate sulfate (SO_4), hydrogen chloride (HCl), hydrogen fluoride (HF), and ammonia (NH_3). Because HCl and HF are not part of the Canadian inventory, these emissions will be calculated for the NAPAP emissions inventory using procedures developed by EPA. In addition, U.S. methane emissions were estimated to provide consistency with Canadian data. These methane emissions are added to U.S. VOC emissions estimates to estimate total hydrocarbon (THC) emissions. These emissions estimates were calculated using point-specific operating rates and process-level emission factors. Emissions data for VOC from natural sources will also be incorporated into the inventory.

2.0 CHALLENGES TO INTEGRATING MULTINATIONAL EMISSIONS INVENTORIES

When two countries historically have developed independent emissions inventories for assessment and modeling purposes, substantial differences in data collection methodologies and data formatting for modeling purposes will exist. The U.S. and Canadian data collection methodologies exhibited differences in data formats, classifications of point and area sources, emission factors, source classification codes, units of measurement, key data elements, and quality control checks. U.S. and Canadian modeling inventories differ in their respective grid sizes, allocation factors, and species classes for VOC and TSP. The inventory methodologies used by each country were modified and standardized in order to ensure consistent processing of data.

Both the U.S. and Canada had somewhat differing point and area source data formats consistent with their national inventory needs, and a compatible joint data format had to be agreed upon in order to ensure consistent processing of data. In addition, some point and area sources were classified differently by the two countries. To alleviate problems in data processing caused by these classification differences, it was agreed that Environment Canada personnel who were familiar with the Canadian data would assign

applicable U.S. Source Classification Codes to Canadian point source records. Where needed, new Source Classification Codes were developed for Canadian sources which did not match any U.S. Source Classification Code.

It was agreed by the two environmental agencies that common emission factors would be used to the extent possible to eliminate discrepancies in final emissions estimates. Environment Canada agreed to use U.S. emission factors except in cases where emission factors specific to Canadian sources were available. Standardization of emission factors was particularly important in the areas of VOC and TSP emissions, where large discrepancies had been discovered in previous inventories (e.g., the 1980 NAPAP emissions inventory).

Because the U.S. and Canada traditionally use different units of measurement, a common approach had to be achieved here also. EPA provided Environment Canada with a metric listing of emission factors to accelerate the data collection process. Canada provided all data to EPA in metric units of measurement. These data were then converted to English units of measurement for computer processing using conversion software developed for the 1980 inventory.

Quality control (QC) efforts consisting of manual and computerized data checking procedures were designed specifically for the 1985 NAPAP emissions inventory. These procedures were designed to ensure that the quality of the data met the requirements of the U.S. and Canadian research communities as closely as possible within the resource constraints of the inventory effort. In the U.S., for example, state data were compared to independent listings as a check for missing facilities. Fuel use comparisons were made with Department of Energy information on utility sources. Comparisons were also made with previous inventories to ensure consistency of emissions magnitudes. A QC report was prepared for each state so that states could validate or correct suspect data.

QC was conducted at all levels of the inventory development. A standard computerized edit checking program used for the state emissions data was made available to Environment Canada, the states, EPA Regional Offices, and contractors to help identify problems such as missing or inconsistent data and data outside valid ranges (stack heights, Universal Transverse Mercator (UTM)

zones, etc.) while the data were still in the hands of the people most knowledgeable about the sources. As the data were entered into the U.S. computer system (NEDS), more checks were employed to ensure that the data were within reasonable limits, and were internally consistent. Environment Canada conducted its own internal QC procedures in addition to supplying EPA with ranges for NAPAP computerized checks of Canadian point source data. In addition, Environment Canada has agreed to send a test data base of inventory information from one province several months prior to sending the complete inventory data base. EPA will format this test data base as needed for computer processing and then process it into a gridded, speciated, and temporally resolved data base to ensure that there will be minimal problems involved in processing the final Canadian data base.

For the largest point sources, namely those emitting more than 2500 tons per year (TPY or 2267 megagrams) of SO_2 or NO_x, an additional QC system was incorporated into the U.S. inventory. This system involved confirmation of SO_2 or NO_x emissions by state personnel. Documentation of the confirmation procedure was sent to Environment Canada so that similar procedures could be initiated in Canada.

For each state, a report discussing possible problems with the data submission was returned to the state and EPA Regional Offices to allow those agencies one final chance to correct and comment on the data base and QC findings. The states returned the QC reports with comments and corrected data. A similar report will be generated for Canada. This effort is the first international emissions inventory in which the data were actually returned to the responsible agencies for their comments and corrections. As a result, the quality of this annual inventory should be better than that of any previously developed inventory.

3.0 SUMMARIES AND ANALYSES OF THE 1985 U.S. EMISSIONS DATA

The following tables and figures summarize current U.S. emissions data in the NEDS computer system for 1985. The data tables and figures represent only U.S. anthropogenic data since, at the time of this writing, Canadian and natural source data have not yet been released in their final form. Table 1

TABLE 1. 1985 U.S. ANTHROPOGENIC EMISSIONS (MAJOR CATEGORIES)

CATEGORY	TYPE		EMISSIONS (10^3 TONS) SO_2	NO_x	VOC
Utility Combustion (UC)	Point		16,177.9	6,771.3	57.0
Industrial Combustion (IC)	Area		662.4	1,404.1	30.9
	Point		1,828.5	1,729.8	160.2
		Subtotal	2,490.9	3,133.9	191.1
Other Combustion (OC)	Area		408.1	618.2	2,402.8
	Point		171.7	95.1	9.8
		Subtotal	579.8	713.2	2,412.6
Industrial Process (IP)	Area*		0.0	0.0	6,200.7
	Point		2,873.1	901.9	2,132.3
		Subtotal	2,873.1	901.9	8,333.0
Transportation (TRAN)	Area		863.6	8,834.4	7,287.7
Other (OTH)	Area		18.9	198.6	3,978.2
	Point		20.0	18.2	11.1
		Subtotal	38.9	216.8	3,989.3
GRAND TOTAL			23,024.2	20,571.5	22,270.7

* For this analysis, certain area source emissions contained within the the Miscellaneous and Additional Area Sources have been compared to the Industrial Process point sources; these area sources include solvent evaporation loss, synthetic organic chemical manufacturing, bulk plants, refinery fugitives, bakeries, pharmaceutical manufacturing, and synthetic fiber manufacturing.

summarizes 1985 emissions data for the three priority pollutants, aggregated into six major source categories; Figure 2 shows that over 90 percent of the SO_2 emissions are from point sources; and Figure 3 indicates that approximately 70 percent of the total SO_2 are from electric utilities. NO_x emissions are split evenly between point and area sources as shown in Figure 2. The electric utilities represent approximately 30 percent of the total NO_x emissions, or 70 percent of the point source NO_x, while mobile sources account for 43 percent of the total NO_x and 80 percent of the area source NO_x (highway vehicles, off-highway vehicles, railroad locomotives, aircraft, and marine vessels), as indicated by Figure 4. Figure 5 shows that VOC emissions are dominated by area source categories, which include mobile sources and small point sources, with mobile sources representing about 33 percent of total VOC emissions. Solvent evaporation loss is the second largest source, representing 32 percent of the total VOC emissions.

The relative importance of point versus area sources for the three pollutants is more clearly illustrated by comparing Figures 6 and 7. SO_2 emissions are dominated by point sources, NO_x emissions are almost evenly split between point and area sources, and VOC emissions are dominated by area sources.

As seen in Table 2, the 1985 NEDS inventory was largely successful in achieving its goal of a consistent baseline year for U.S. data. With few exceptions, the data represent 1985 emissions estimates and 1985 operating data. The second major objective for the 1985 NEDS effort was to compile a complete inventory of the data items that are most important to the modeling and NAPAP user community. Figure 8 shows that this objective was met since the vast majority of data elements were obtained for priority plants (those emitting more than 1000 tons of SO_2, NO_x, or VOC per year) for the 1985 NEDS inventory.

4.0 DOCUMENTATION

For the U.S. data, an extensive audit trail was developed to document both problems with the data and the history of the data. All the results of the QC measures performed on the data have been documented in memos kept in a

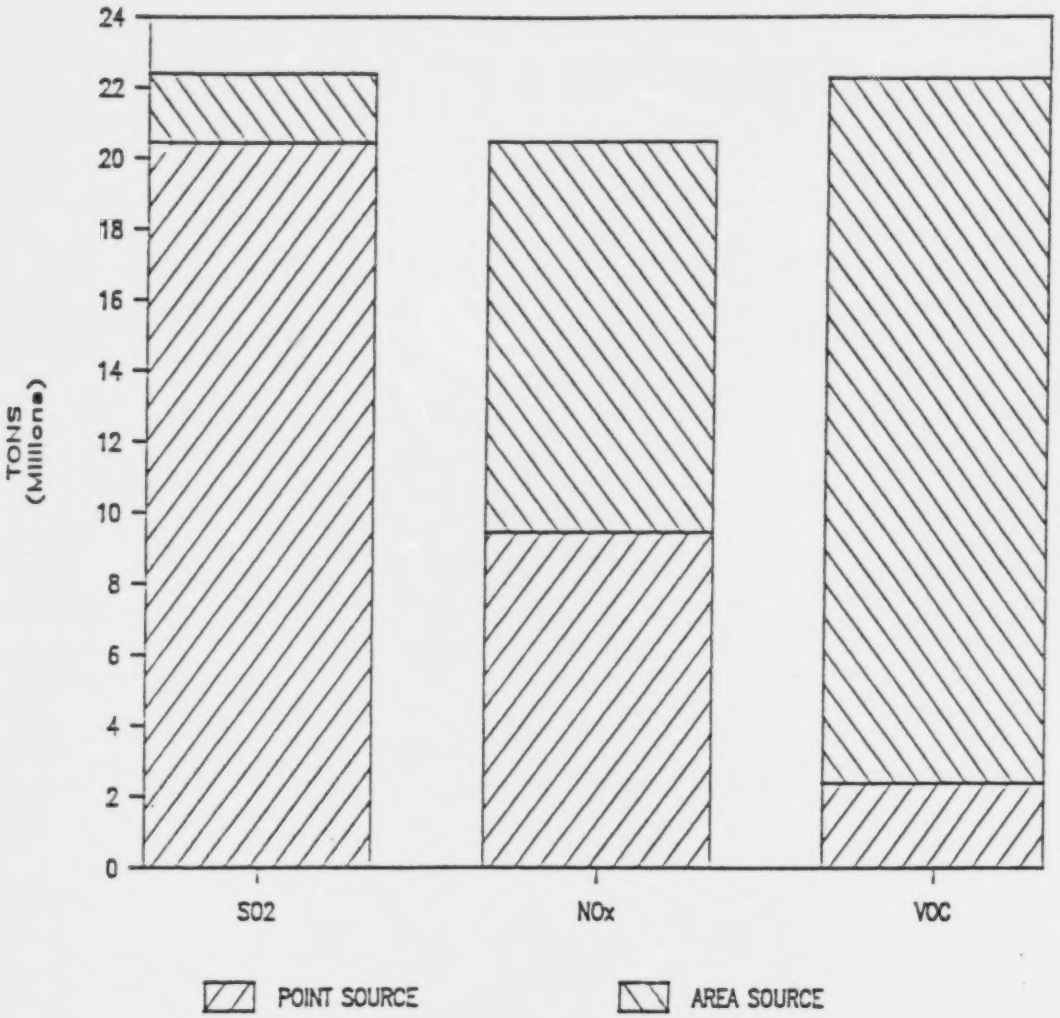


Figure 2. Comparison of U.S. Point and Area Sources

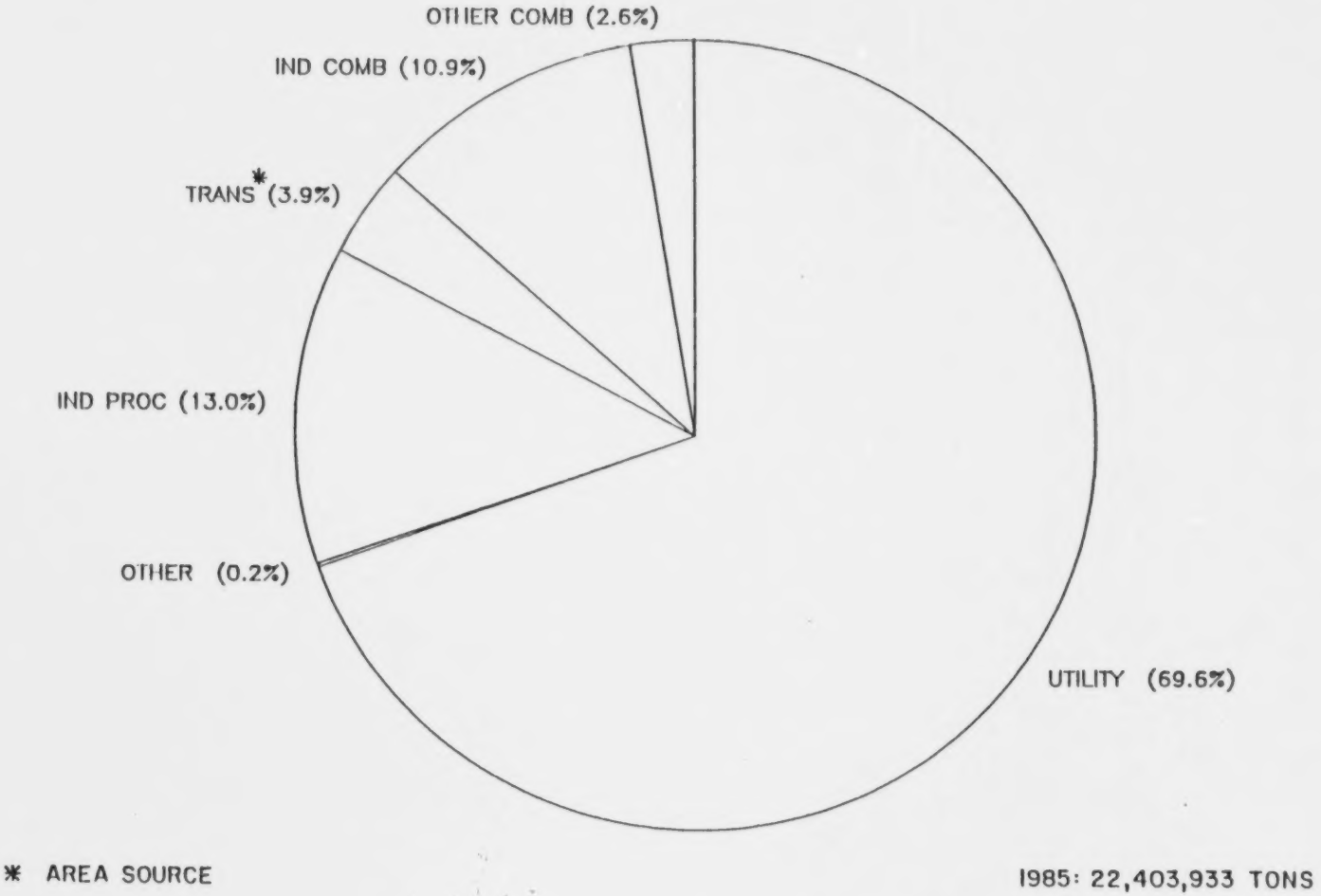


Figure 3. Major 1985 United States SO_2 Categories and Emissions

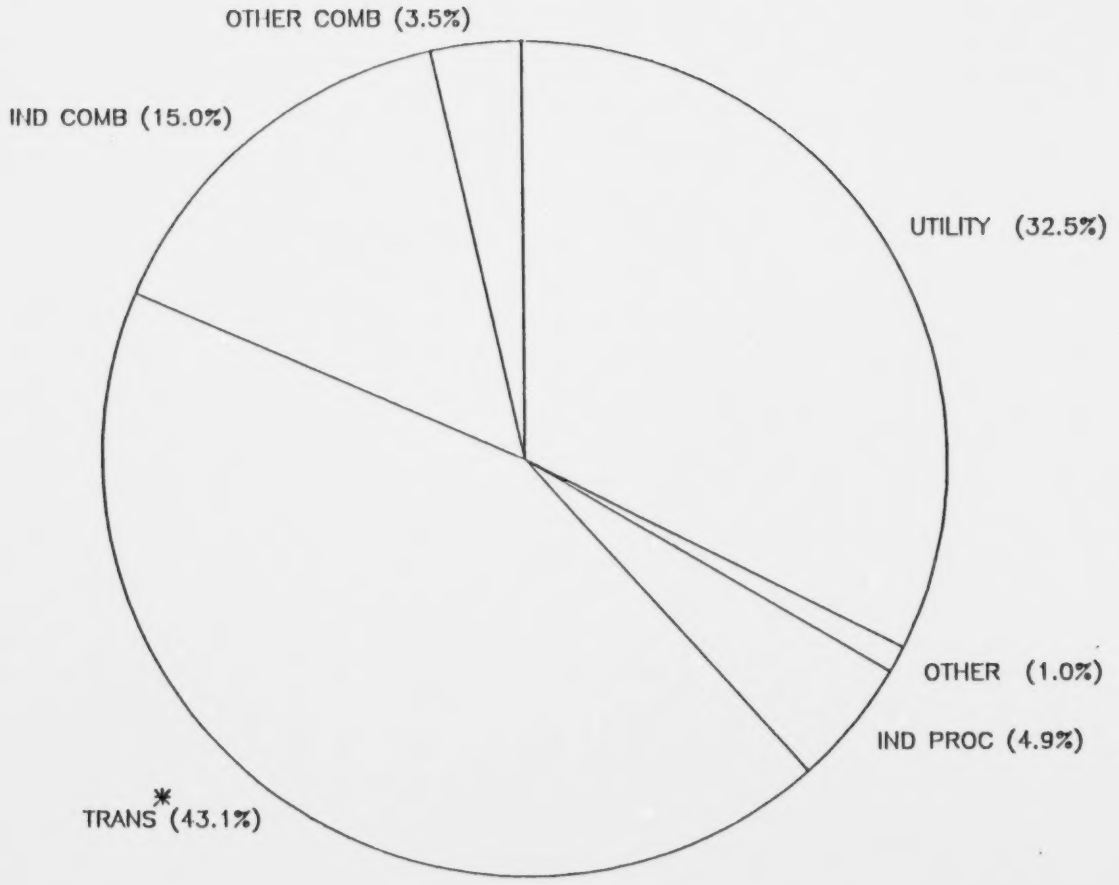


Figure 4. Major 1985 United States NO_x Categories and Emissions

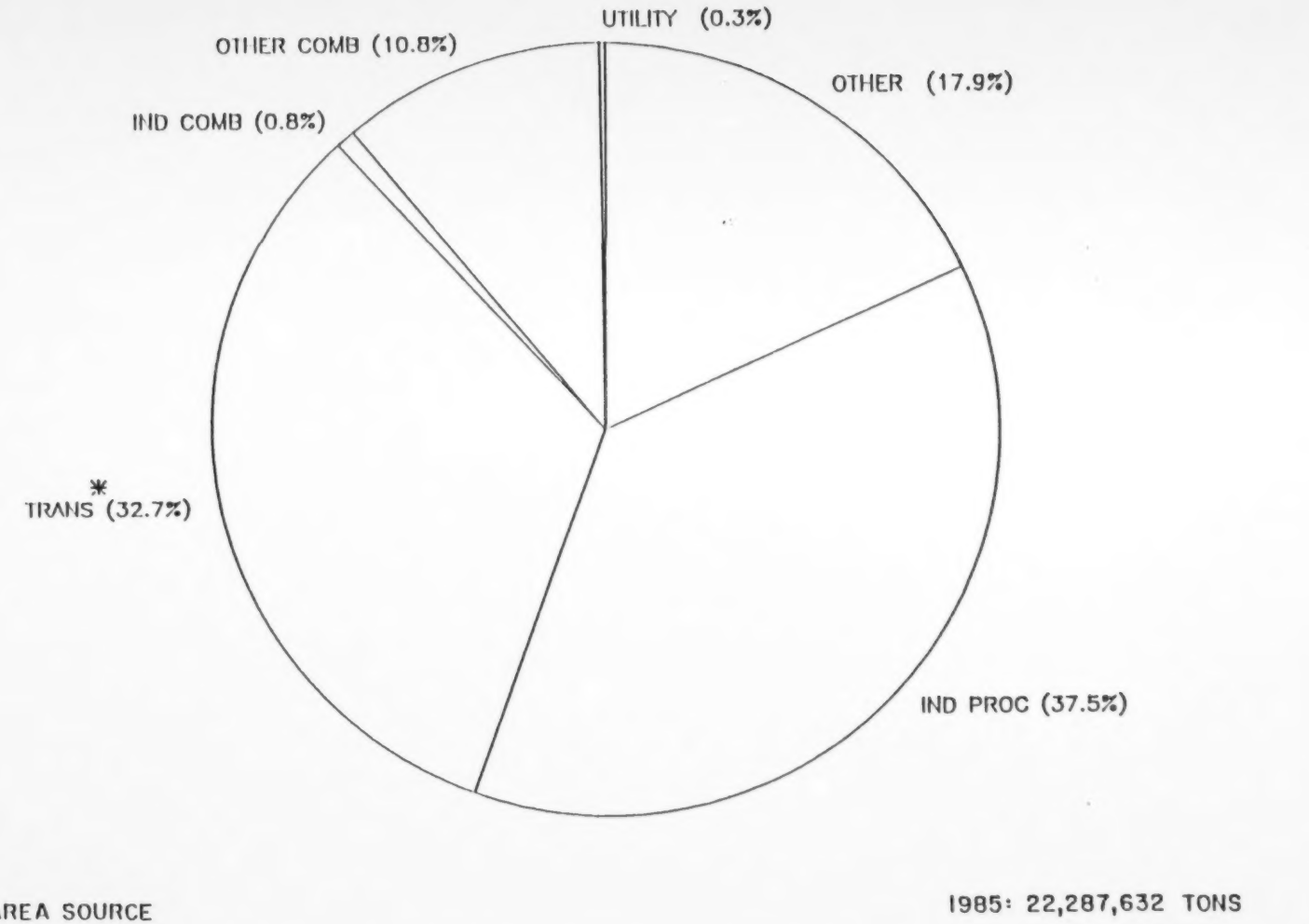
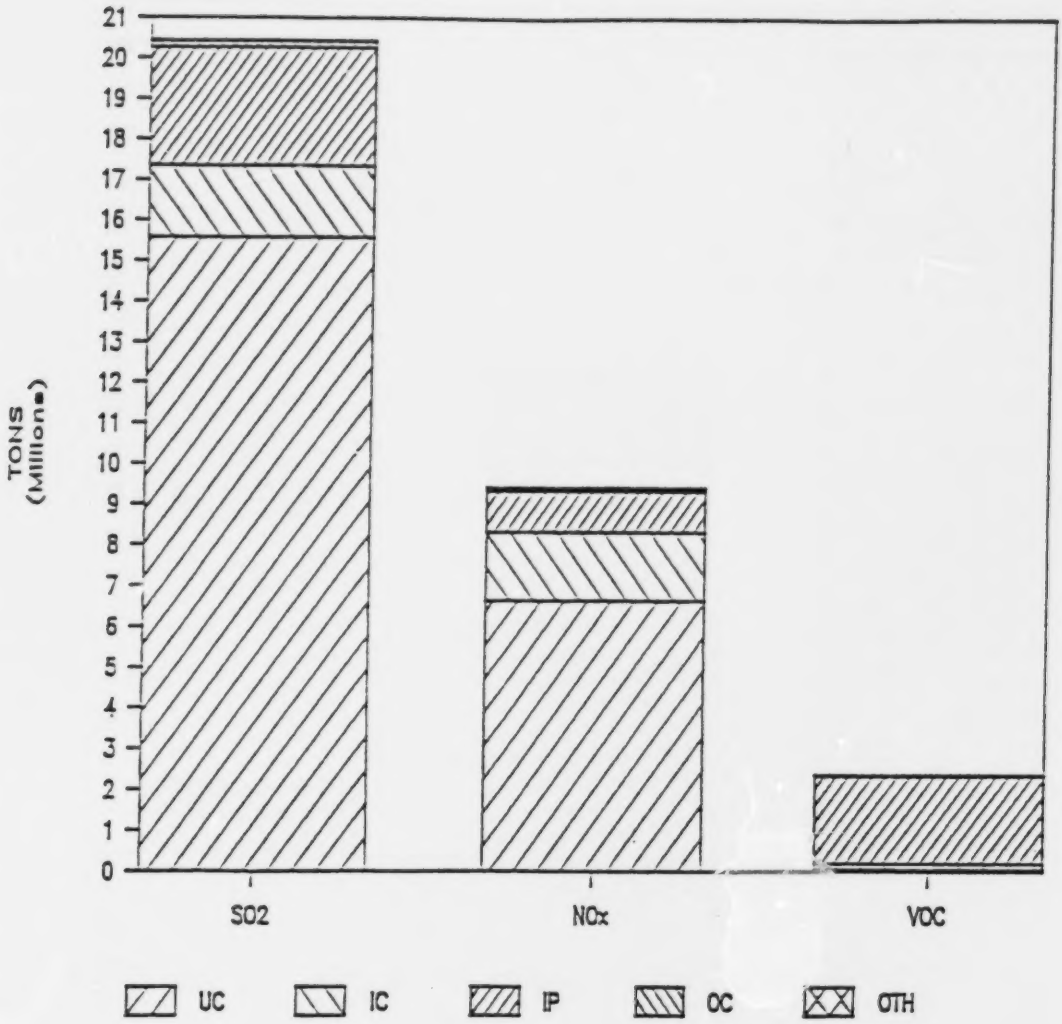
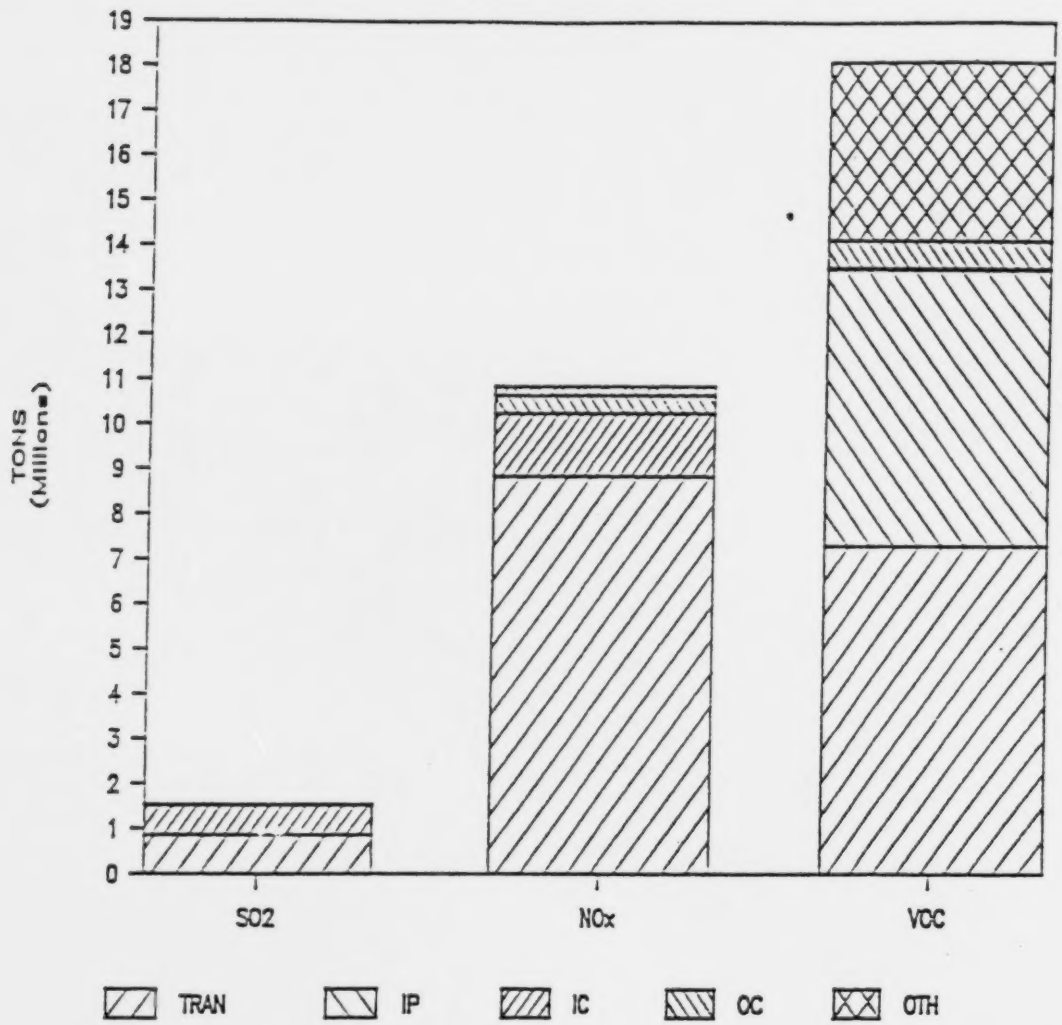


Figure 5. Major 1985 United States VOC Categories and Emissions



UC = Utility Combustion
IC = Industrial Combustion
IP = Industrial Process
OC = Other Combustion
OTH = Other Sources

Figure 6. U.S. Anthropogenic Point Source Emissions



TRAN = Transportation
IP = Industrial Process
IC = Industrial Combustion
OC = Other Combustion
OTH = Other Sources

Figure 7. U.S. Anthropogenic Area Source Emissions

TABLE 2. YEAR OF RECORD SUMMARY BY PLANT IN THE 1985 NEDS (1000 TON PLANTS)

	77	78	79	80	81	82	83	84	OTHER	85	NON-85 (SUBTOTAL)	TOTAL
Alabama										57	0	57
Arizona										14	0	14
Arkansas										35	0	35
California										82	0	82
Colorado										16	0	16
Connecticut										9	0	9
Delaware						1				10	1	11
Dist. of Col.										1	0	1
Florida										63	0	63
Georgia							1			38	1	39
Idaho										6	0	6
Illinois										128	0	128
Indiana										75	0	75
Iowa										36	0	36
Kansas										48	0	48
Kentucky										53	0	53
Louisiana										122	0	122
Maine										16	0	16
Maryland										19	0	19
Massachusetts										24	0	24
Michigan										109	0	109
Minnesota										36	0	36
Mississippi										34	0	34
Missouri										77	0	77
Montana										15	0	15
Nebraska										11	0	11
Nevada										4	0	4
New Hampshire										4	0	4
New Jersey										23	0	23
New Mexico										41	0	41
New York										54	0	54
North Carolina								1		41	1	42
North Dakota										14	0	14
Ohio										118	0	118
Oklahoma										40	0	40
Oregon										14	0	14
Pennsylvania								2		100	2	102
Rhode Island										2	0	2
South Carolina							1			35	1	36
South Dakota										4	0	4
Tennessee										60	0	60
Texas										302	0	302
Utah										13	0	13
Vermont										2	0	2
Virginia										55	0	55
Washington										33	0	33
West Virginia					3			1		42	4	46
Wisconsin										51	0	51
Wyoming										20	0	20
TOTAL	0	0	0	0	3	1	2	4		2206	10	2216

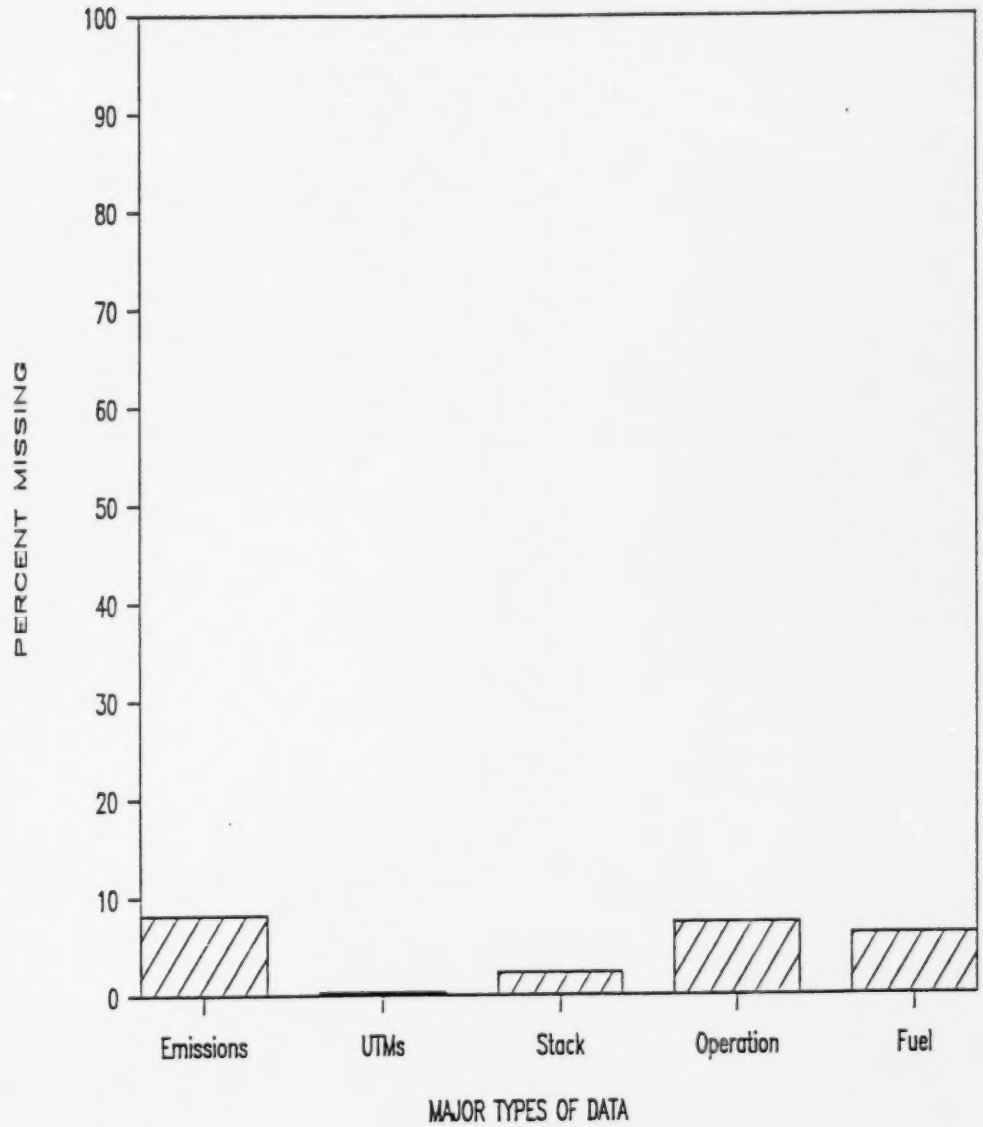


Figure 8. 1985 Missing Point Source Data Summary for Priority Plants

QC notebook. When the problems resulted in corrective action, the changes to the data were listed in computerized files called the audit trail. The audit trail lists the source identifiers, the old and new data values, the date of the change, and the party responsible for the change for the U.S. emissions data.

Data tapes containing the final 1985 U.S. anthropogenic point and area source data will be available to the public during 1989. These tapes will contain a more comprehensive collection of data than is reported here. The audit trail files are also available to users of the data to help them identify the source of a data element.

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